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A PERSONAL COOLING SYSTEM FOR HELICOPTER PILOTS

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21 NOVEMBER 1977

PHASE REPORT
AIRTASK NO. A340-0000/001D/7F51-523-000
Work Unit No. ZB104

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Prepared for
NAVAL AIR SYSTEMS COMMAND
Department of the Navy
Washington, D.C. 20361

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REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: NADC-77289-60 (14)	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER (9)	
4. TITLE (and Subtitle): A PERSONAL COOLING SYSTEM FOR HELICOPTER PILOTS, (6)	5. TYPE OF REPORT & PERIOD COVERED: Phase Report, 1 Oct 76 - 30 Sep 77,
6. PERFORMING ORG. REPORT NUMBER	
7. AUTHOR(s): Suzanne M. Reeps (10)	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Aircraft & Crew Systems Technology Directorate, Naval Air Development Center, Warminster, PA 18974	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: AirTask No. A340/0000/001D/ 7F51-523-000, W.U. ZB104
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Air Systems Command (AIR-340), Department of the Navy, Washington, DC 20361 (11)	12. REPORT DATE: 21 November 1977 (12) 12 p.
	13. NUMBER OF PAGES: 8
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): (16) F51523 (17) F5152300	15. SECURITY CLASS. (of this report): UNCLASSIFIED
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Personal Cooling System
Liquid Circulating Garment

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The NAVAIRDEVCEN (Naval Air Development Center) is developing a personal cooling system for helicopter pilots to alleviate the heat stress encountered during exposure to high ambient temperatures. The major components of this system are a lightweight, constant-wear, liquid circulating garment (LCG) outfitted with skin temperature sensors, a cooling generator, and an automatic controller. The liquid circulation garment is designed for wear under a standard flight coverall and is connected, upon aircraft entry, to the

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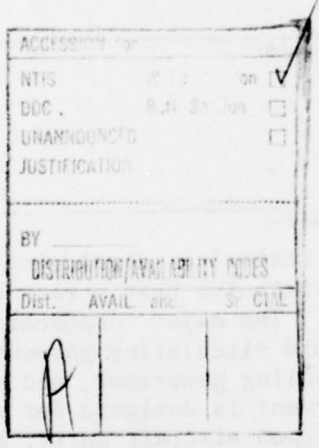
20. generator and automatic controller. During flight, the system automatically maintains the pilot and copilot in thermal comfort thereby enabling more effective performance of flight duties. The system is currently under a development contract.



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INTRODUCTION

Naval helicopter pilots and copilots are currently faced with assigned flight duties which involve the exercise of intellective and psychomotor skills rather than distinct physical work. This requires a high degree of skill and coordination. One major problem which seriously degrades their performance and effectiveness is the excessive heat buildup resulting from exposure to ambient temperatures of up to 46°C (115°F). Since no air conditioning of the helicopter is possible due to lack of air tight integrity, alleviation of the heat stress must be dealt with on a personal equipment basis[1].

The planned approach to this problem is to develop a personal cooling system. The cooling system will consist of an aircraft mounted personal cooling generator and automatic controller and a constant wear liquid circulating garment (LCG) outfitted with skin temperature sensors. The total system shall maintain each of two individual users in thermal comfort thereby enabling the aircrewmen to more effectively perform their flight duties. The personal cooling system is being developed for the Naval Air Systems Command (AIR-340B) under Airtask No. A340-0000/001D/7F51-523-000, Work Unit No. ZB104.

CONCEPT OF THE SYSTEM

As conceived, the system will function as follows: Under normal flight conditions, the aircrewmen will wear a liquid circulating garment (LCG) through which a 50/50 water/glycol solution will be circulated. The LCG will be a closed loop system which is connected, upon aircraft entry, to the cooling generator and automatic controller. Operation of the system will be airman initiated once the pilot and copilot are seated and ready for flight. Once initiated, the system will work automatically to maintain the two users in thermal comfort as evidenced by maintenance of their mean skin temperatures between 30° and 34.5°C (86° - 94°F), stabilizing at an individually selected set point of 32°, 33° or 34°C. No adjustments or judgments will be required of the aircrewmen during the flight mission. A general description of each of the major components of the system follows. Figure 1[2] provides a schematic description and figure 2 illustrates an artist's conception of the system configuration.

DESCRIPTION OF THE LIQUID CIRCULATING GARMENT (LCG)

The liquid circulating garment, which will initially be used for evaluation of the system concept, is constructed of a nylon spandex fabric with an

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[1] *Winsko, S.J. and Hellman, A.S.: Aircrew Protective Clothing and Devices System (Rotary Wing Aircraft). NADC Report No. NADC-74215-40 of 1 Nov 1974.*

[2] *Rovac Variable Capacity Air Cycle Helicopter Pilot Cooling System; Proposal submitted in response to Solicitation No. N62269-77-R-0275, 19 Apr 1977, by the Rovac Corporation.*

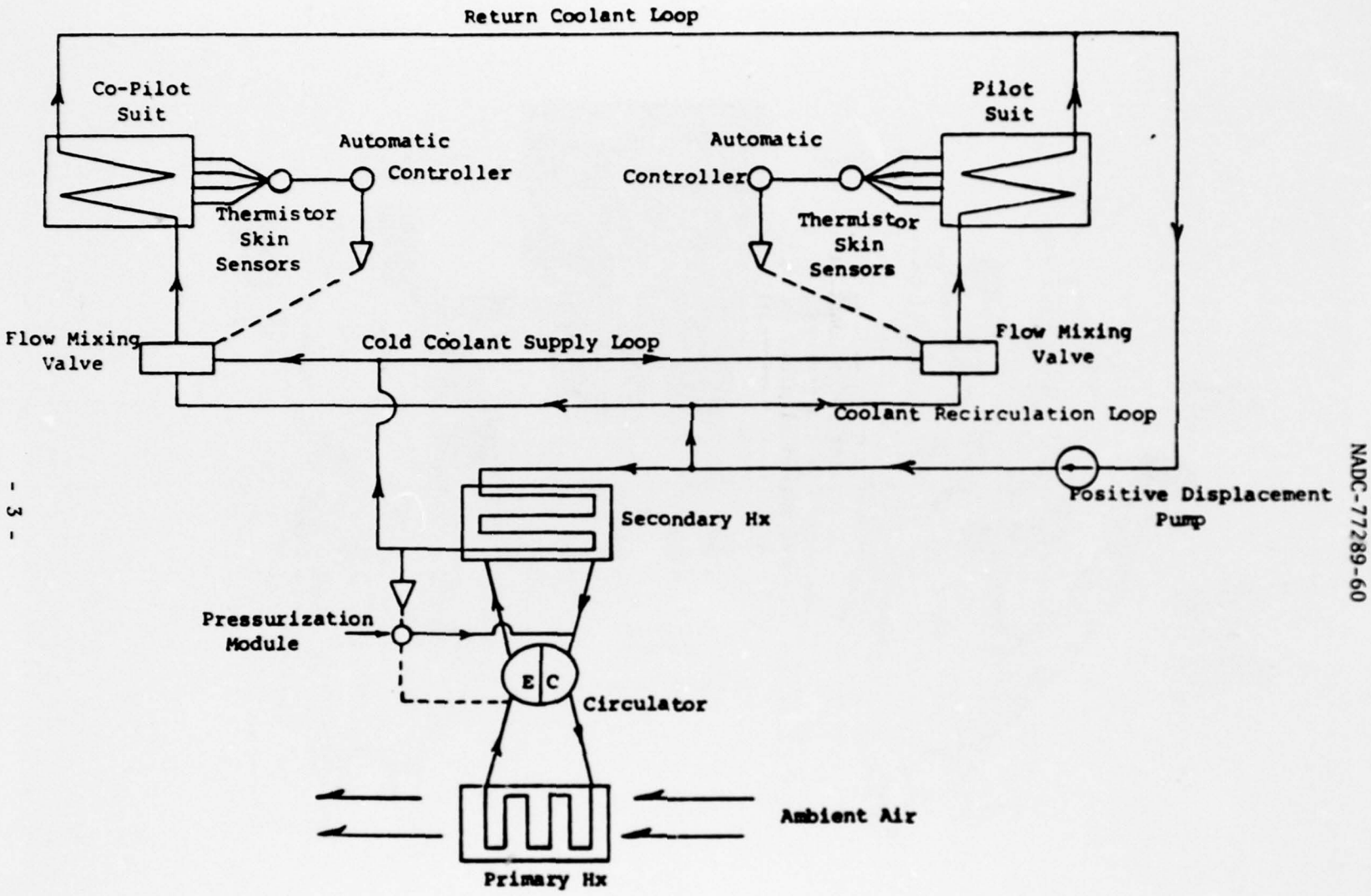

FIGURE 1 - Proposed Helicopter Pilot Cooling System Configuration.

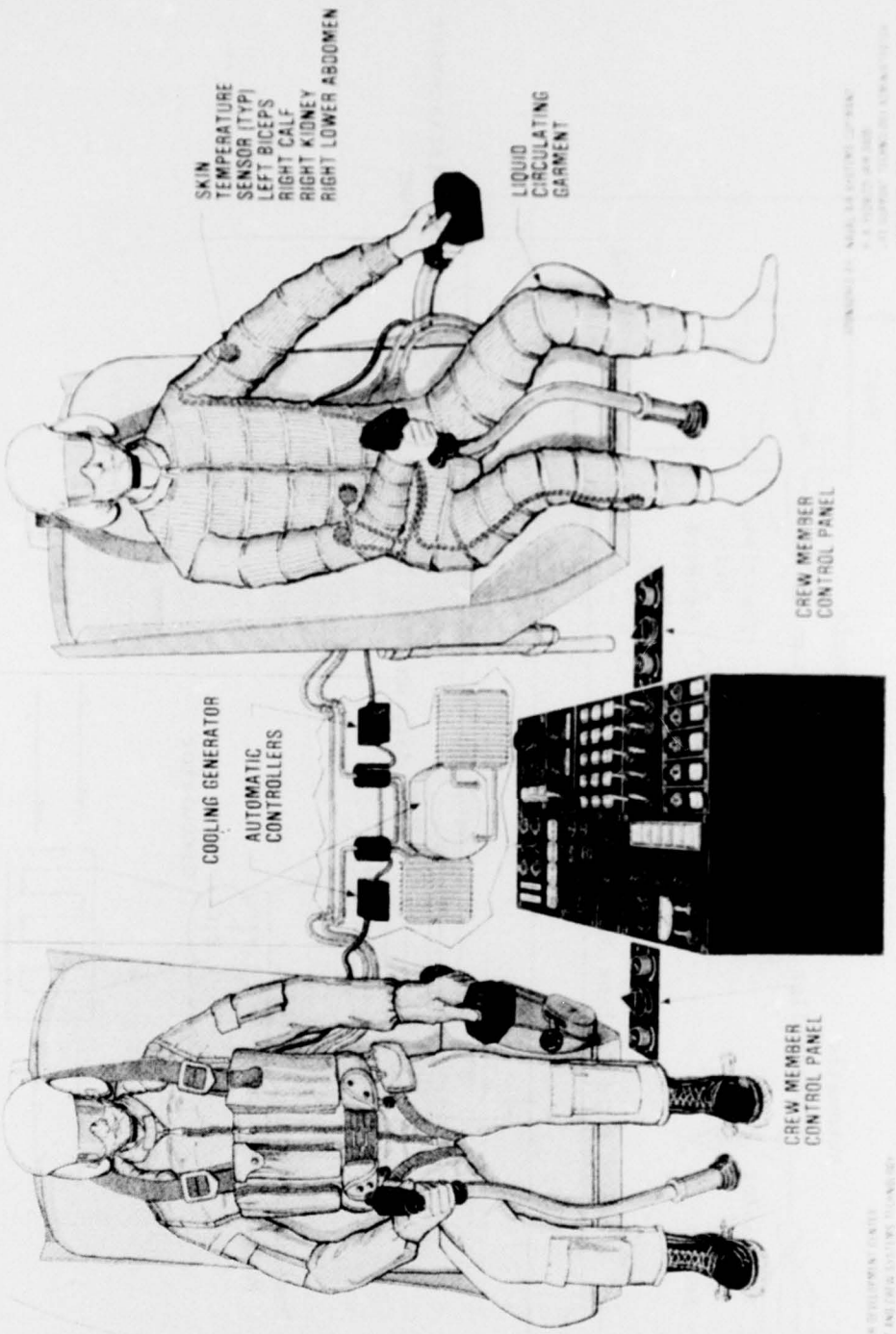

FIGURE 2 - Personal Cooling System for Helicopter Pilots.

integral capillary-like system of small diameter flexible plastic tubing. The tubing will permit continuous circulation of the cooled liquid between the cooling generator and the garment. The full length garment which weighs approximately 3.5 pounds will provide cooling to all portions of the body with the exception of the head, neck, hands and feet. Future program efforts in the development of an operational garment will be aimed at improving its comfort, mobility, reliability, maintainability and fire resistance. Four skin temperature sensors will be installed in the garment to provide the physiological feedback required by the automatic controller. The garment will be worn under a standard flight coverall.

DESCRIPTION OF THE COOLING GENERATOR

The cooling generator which is currently under development[3] is a variable capacity air cycle system which uses two heat exchangers in conjunction with a compressor-expander circulator (figure 3)[2]. During operation, ambient air enters the compressor side of the circulator where it is pressurized thereby raising its temperature to approximately 121.5°C (250°F). The hot, compressed air then passes through the primary heat exchanger where it is cooled by fan air to approximately 46.5°C (115°F). Still at high pressure, the cooled air passes into the expander side of the circulator where it is depressurized. This cools the air temperature greatly (to 0°C). This cold air then passes into the secondary heat exchanger where it extracts heat from the warmed liquid returning from the LCG. The warmed air then returns to the compressor side of the circulator thus completing the cycle.

Connected to the cooling generator will be a positive displacement pump which will maintain a constant flow rate of cooled liquid through the LCG of 56.8 liters (15 gallons) per hour. The cooling generator will use no fluorocarbons or refreezable ice packs for refrigeration. It will be powered by available power sources in the aircraft.

DESCRIPTION OF THE AUTOMATIC CONTROLLER

The automatic controller currently under development[3], will be an analog type containing the electronic logic to average the temperatures from the four skin temperature sensors. It will provide temperature control by sending a current to a flow mixing valve which will proportionately mix warmed returning liquid from the LCG with cooled liquid from the generator. This approach will provide "fast response to load changes induced by system and pilot environmental effects"[2]. A single controller will monitor both helicopter pilots simultaneously and independently. It will continuously monitor changes in mean skin temperature and respond with stable and dynamic control of the water coolant temperature.

PROGRESS TO DATE

The program for development of a personal cooling system was initiated during FY-77. To date, a development contract has been awarded for development

[3]*Contract No. N62269-77-C-0275, 25 Aug 1977, issued to the Rovac Corporation.*

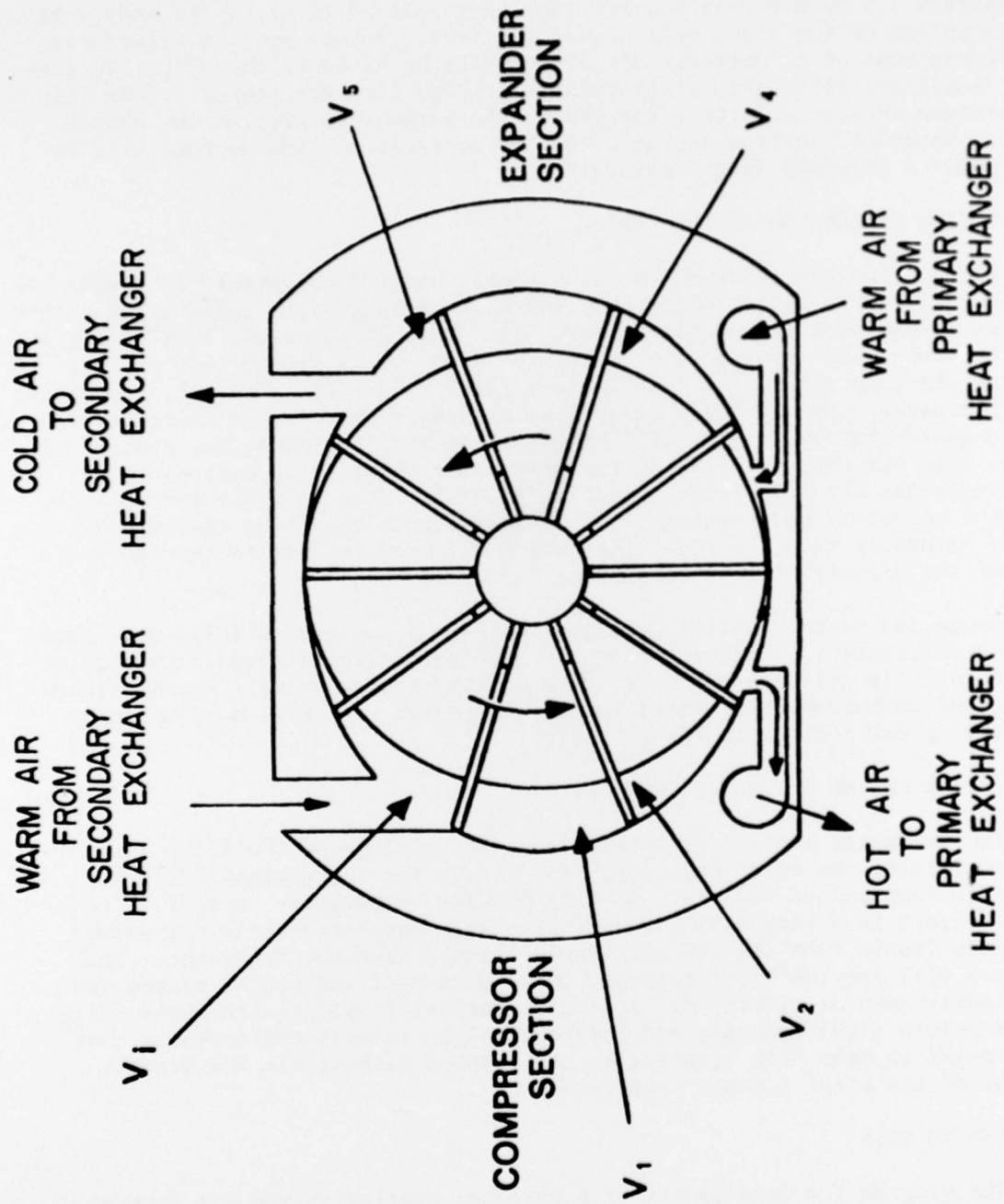

FIGURE 3 - Generalized Schematic End-View of the ROVAC Circulator.

of a prototype generator, controller and two sets of skin temperature sensors[3]. Delivery of hardware is scheduled for April 1978. Upon delivery, this hardware will be subjected to extensive testing to determine the ability of the system to maintain thermal comfort for 6 hours in ambient temperatures up to 46°C (115°F).

Additionally, an ILS Plan has been drafted and is awaiting approval. A Test and Evaluation Master Plan (TEMP) is also being prepared in conjunction with the Operational Test and Evaluation Force.

FUTURE PLANS

During FY-78, efforts will be focused on development of a fire resistant fabric for use in the LCG. Procurement of prototype garments using the developed fabric will also be initiated during FY-78. The garment design will be based on technology being developed under contract to NASA with appropriate modifications as required for military use. Figure 4 provides details of follow-on development work as currently scheduled through Fleet Approval for service use and release for production.

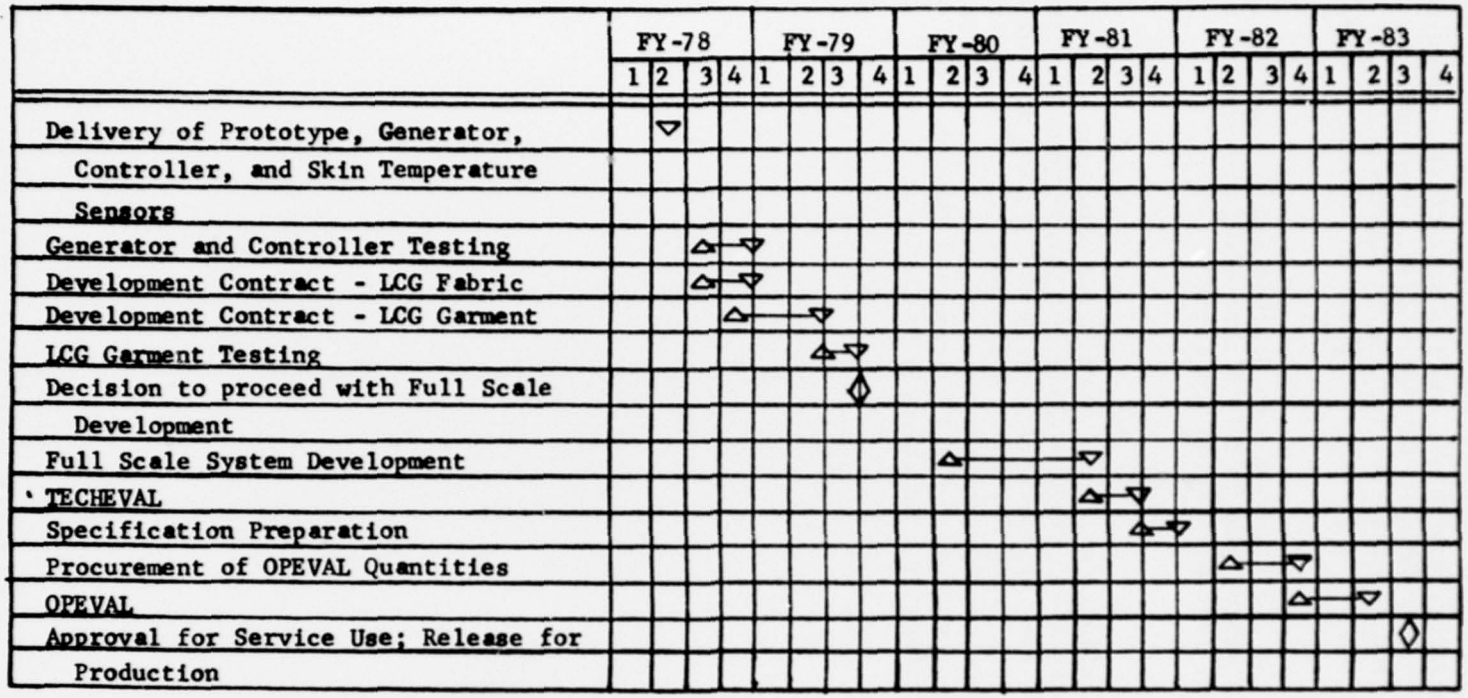

Figure 4 - Milestone Schedule.

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